

## PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2003-068282**

(43)Date of publication of application : **07.03.2003**

(51)Int.Cl.

H01M 4/02

H01M 4/58

H01M 4/62

H01M 10/40

(21)Application number : **2001-372478**

(71)Applicant : **SHIN KOBE ELECTRIC MACH CO  
LTD**

(22)Date of filing : **06.12.2001**

(72)Inventor : **NAKAI KENJI  
KOISHIKAWA YOSHIMASA  
HIRONAKA KENSUKE**

(30)Priority

Priority number : **2001180065** Priority date : **14.06.2001** Priority country : **JP**

### (54) NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a nonaqueous electrolyte secondary battery of high safety with high capacity and high output.

SOLUTION: A positive electrode active material mixture is made by mixing lithium manganate powder of spinel crystal structure, which has Li/Mn ratio of 0.52 and a mean particle diameter of about 20  $\mu\text{m}$ , flake graphite of a mean particle diameter of 18  $\mu\text{m}$ , and PVDF or thermosetting plasticized polyvinyl alcohol in the mixing ratio of 85:10:5 to 85:12:3. NMP as dispersing solvent is added to the positive electrode active material mixture to be kneaded, the resultant slurry is coated on the both surfaces of an aluminum foil of 20  $\mu\text{m}$  in thickness to obtain spread of lithium manganate of 80-160 g/m<sup>2</sup>. The heating value, followed on the chemical reaction between the nonaqueous electrolyte and the positive electrode active material mixture, is reduced, and sharp and large volume of gas generation is controlled in a cylindrical lithium ion battery.

### LEGAL STATUS

[Date of request for examination]	18.07.2003
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3591506
[Date of registration]	03.09.2004
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

\* NOTICES \*

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

DETAILED DESCRIPTION

---

[Detailed Description of the Invention]

[0001]

[Field of the Invention] the positive active material containing the lithium manganese multiple oxide and electric conduction material which this invention requires for a nonaqueous electrolyte rechargeable battery, and have a spinel mold crystal structure especially, and a binder -- a mixture to both sides of a band-like charge collector with the positive electrode by which equal amount application was carried out mostly the negative electrode which becomes the carbonaceous object and binder which can emit [ occlusion and ] a lithium ion, and a selection target from electric conduction material by charge and discharge -- with the negative electrode by which equal amount application was carried out mostly, a mixture to both sides of a band-like charge collector It is related with the nonaqueous electrolyte rechargeable battery held in the cell container which has the internal pressure disconnection device in which internal pressure is opened for the electrode winding group wound through the separator by place constant pressure.

[0002]

[Description of the Prior Art] The rechargeable lithium-ion battery representing a nonaqueous electrolyte rechargeable battery is mainly used for the power source of portable devices, such as a VTR camera, and a notebook computer, a cellular phone, taking advantage of the merit which is a high energy consistency. Let the internal structure of this cell be a winding type as usually shown below. It is band-like [ by which the metallic foil was plastered with the active material ], a cross section is spirally wound so that a positive electrode and a negative electrode may not contact directly on both sides of a separator, and as for an electrode, the positive electrode and the negative electrode form the winding group. This winding group is contained by the cell can of the shape of a cylinder used as a cell container, and it obturates it after electrolytic-solution pouring in.

[0003] The diameter called 18650 molds is 18mm, height is 65mm, and the dimension of a common cylindrical shape rechargeable lithium-ion battery has spread widely as a small noncommercial use lithium ion battery. The cobalt acid lithium characterized by high capacity and the longevity life is mainly used for the positive active material of a 18650 mold rechargeable lithium-ion battery, in general, cell capacity is 1.3Ah(s) - 1.8Ah, and an output is about 10W.

[0004] On the other hand, that an environmental problem should be coped with on an automobile-industry community, development of the electric vehicle which used the source of power without an exhaust gas only as the cell completely, and the hybrid (electrical and electric equipment) automobile which makes both an internal combustion engine engine and a cell the source of power is accelerated, and it is coming to the phase of utilization in part.

[0005] The property that naturally high power and high energy are obtained is required of the cell used as the power source of an electric vehicle, and the lithium ion battery attracts attention as a cell which matched this demand. For the spread of electric vehicles, low-pricing of a cell is indispensable, and for that purpose, the low cost cell ingredient was called for, for example, when it was positive active material, especially the oxide of manganese abundant in resource attracted attention, and the

improvement which aimed at high performance-ization of a cell has been made. Moreover, as a cell for electric vehicles, the high increase in power which influences not only high capacity but the acceleration engine performance etc., i.e., reduction of the internal resistance of a cell, is called for. Furthermore, the reinforcement of a cell is also called for that it should correspond to the long-term duration of service of an electric vehicle. Continue and reinforcement here is satisfied with a long period of time of not only cell capacity but electrical energy serviceability required for controlling the fall of an output and making it running an electric vehicle.

[0006]

[Problem(s) to be Solved by the Invention] However, in the case of a lithium ion battery, the more it becomes high capacity and high power, the more it is in the inclination for safety to fall, and when especially an output is a large cell, the inclination for the phenomenon when a cell lapsing into an abnormal condition to become a little intense is seen. Since high current charge and high current discharge are made as for a cell of high capacity and high power which is used for the power source for electric vehicles, it is substantially impossible to establish the current cutoff device (a kind of cutting switch) which operates according to the cell internal pressure rise at the time of abnormalities which are generally adopted as the 18650 mold lithium ion battery in cell structure.

[0007] people -- putting -- running -- an electric vehicle -- a case -- charge -- a control system -- having broken down -- a case -- overcharge -- the time -- unexpected -- a collision -- it is -- a case -- it may encounter -- a cell -- crash -- the time -- or -- a foreign matter -- a thrust -- a prickle -- carrying out -- the time -- the very important cell property which needs the thing of the cell at the time of an external short circuit etc. itself for which safety is secured -- it is . In addition, the safety of a cell means suppressing the damage to a car to the minimum with not inflicting physical damage on people having the natural behavior of a cell when a cell is exposed to an unusual condition.

[0008] In view of an upper report proposal, this invention makes it a technical problem to offer a nonaqueous electrolyte rechargeable battery with very high safety, though it is high capacity and high power.

[0009]

[Means for Solving the Problem] the positive active material with which this invention contains the lithium manganese multiple oxide and electric conduction material which have a spinel mold crystal structure, and a binder in order to solve the above-mentioned technical problem -- a mixture to both sides of a band-like charge collector with the positive electrode by which equal amount application was carried out mostly the negative electrode which becomes the carbonaceous object and binder which can emit [ occlusion and ] a lithium ion, and a selection target from electric conduction material by charge and discharge -- with the negative electrode by which equal amount application was carried out mostly, a mixture to both sides of a band-like charge collector In the nonaqueous electrolyte rechargeable battery held in the cell container which has the internal pressure disconnection device in which internal pressure is opened for the electrode winding group wound through the separator by place constant pressure The amounts of application per said charge collector one side of said lithium manganese multiple oxide are 80 g/m<sup>2</sup> thru/or 160 g/m<sup>2</sup>. and the mass of said electric conduction material -- positive active material -- 10 mass [ of a mixture ] % thru/or 12 mass % -- it is -- and the mass of said binder -- positive active material -- it is characterized by being 3 mass [ of a mixture ] % thru/or 5 mass %.

[0010] the positive active material which contains the lithium manganese multiple oxide and electric conduction material which have a spinel mold crystal structure, and a binder in this invention in order to secure high capacity and the nonaqueous electrolyte rechargeable battery of high power -- the negative electrode and \*\* which can emit [ occlusion and ] a lithium ion are used by the positive electrode with which equal amount application of the mixture was mostly carried out to both sides of a band-like charge collector, and charge and discharge. in high capacity and the nonaqueous electrolyte rechargeable battery of high power, when it lapses into an abnormal condition, high current charge or a high current discharge condition maintains -- having -- nonaqueous electrolyte and an active material -- by generation of heat accompanying a chemical reaction with a mixture, a lot of [ rapid within a cell container and ]

gas occurs, and the internal pressure of a cell container is raised. Generally, although it has the internal pressure disconnection device in which internal pressure is opened by place constant pressure in a cell container in order that a nonaqueous electrolyte rechargeable battery may prevent the internal pressure rise in a cell container the amount of application per charge collector one side of a lithium manganese multiple oxide -- 80g/m<sup>2</sup> thru/or 160 g/m<sup>2</sup> -- carrying out -- and the mass of electric conduction material -- positive active material, since calorific value can be reduced by considering as 10 mass [ of a mixture ] % thru/or 12 mass % The gas evolution from an internal pressure disconnection device is performed very quietly. furthermore, the mass of a binder -- positive active material -- considering as 3 mass [ of a mixture ] % thru/or 5 mass % -- positive active material -- since exfoliation of a mixture and omission can be prevented, an early capacity and the fall of an output can be controlled. Therefore, according to this invention, though it is high capacity and high power, a nonaqueous electrolyte rechargeable battery with very high safety is realizable.

[0011] In this case, if the mixture of a graphite and non-fixed form carbon is used for electric conduction material, it can consider as the nonaqueous electrolyte rechargeable battery of high power more, and if the mass ratio of the graphite at this time and amorphous carbon is set to 80:20-90:10, it can consider as high power further. Moreover, if the mean diameter of a graphite can be used as the nonaqueous electrolyte rechargeable battery of the 0.2 times thru/or 0.8 times, then twist high power of the mean diameter of a lithium manganese multiple oxide which has a spinel mold crystal structure and non-fixed form carbon is made into acetylene black, the nonaqueous electrolyte rechargeable battery of high power can be obtained further. Furthermore, an output maintenance factor can be raised, without accompanying the Li/Mn ratio of a lithium manganese multiple oxide by 0.55 thru/or 0.60, then the fall of capacity. Moreover, an output maintenance factor can be raised, without being accompanied by the fall of the thing expressed with  $\text{Li}_{1+x}\text{Mn}_{2-x-y}\text{MyO}_4$  (at least one sort of elements chosen from the group which  $0 < x \leq 0.1$  becomes in x, and  $0 < y \leq 0.3$  and M become from Al, Cr, nickel, Co, and Mg in y) in a lithium manganese multiple oxide, then capacity. Furthermore, if amorphous carbon is used for the active material of a negative electrode, it can consider as the nonaqueous electrolyte rechargeable battery which are high power and high capacity and was further excellent in safety.

[0012] Furthermore, if the thermosetting plasticization polyvinyl alcohol resin which made polyvinyl alcohol the subject and denaturalized to the binder of a positive electrode and/or a negative electrode is used, an output maintenance factor can be raised, without being further accompanied by the fall of capacity.

[0013]

[Embodiment of the Invention] The gestalt of the operation which applied hereafter the nonaqueous electrolyte rechargeable battery built over this invention with reference to a drawing to the cylindrical shape lithium ion battery for hybrid electric vehicles is explained.

[0014] (Production of a thermosetting plasticization polyvinyl-alcohol-resin binder constituent) That by which the mixed dissolution of the first resinous principle which consists of thermosetting polyvinyl alcohol system resin, and the second resinous principle which consists of an acrylic resin system plasticizer is carried out into the suitable solvent (it is called a N-methyl-2-pyrrolidone and Following NMP in this example.) was used for thermosetting plasticization polyvinyl alcohol resin. The thermosetting polyvinyl alcohol system resin which is the first resinous principle makes cyclic anhydrides, such as for example, a succinic-acid anhydride, react to about about 2000 average degree of polymerization polyvinyl alcohol system resin in the anhydrous condition substantially under catalyst existence, such as inside of organic solvents, such as NMP, and triethylamine, and is obtained. The reaction rate of polyvinyl alcohol system resin and a cyclic anhydride is good for the anhydride radical of a cyclic anhydride to consider as about 0.1Eq to 1Eq of alcoholic hydroxyls of polyvinyl alcohol system resin.

[0015] The acrylic resin system plasticizer which is the second resinous principle has the suitable reactant of laurylacrylate / acrylic-acid copolymerization object, and a 2 organic-functions mold epoxy resin.

[0016] Hereafter, the thermosetting plasticization polyvinyl-alcohol-resin constituent used with this

operation gestalt is compounded as follows.

[0017] The first resinous principle was compounded as follows. Polyvinyl alcohol 51g and NMP650g of about 98% of saponification degrees, and toluene 10g were supplied, and the temperature up was carried out to the separable flask equipped with an agitator, a thermometer, a cooling pipe, distillate ruble, and nitrogen gas installation tubing over about 30 minutes at 195-degreeC, agitating with nitrogen bubbling. It is kept warm at this temperature for 2 hours, and azeotropy of the moisture was carried out and the moisture in a flask was made to distill off by making toluene flow back. Subsequently, distilling off toluene, cooling to 120-degreeC and keeping it warm at this temperature, it added and 1 time amount reaction of the 7.7g of the succinic-acid anhydrides was carried out (an acid-anhydride radical is about 0.07Eq to 1Eq of alcoholic hydroxyls of polyvinyl alcohol). It cooled to the room temperature and the first resinous principle obtained the NMP solution of about 8 mass %.

[0018] The second resinous principle was compounded as follows. Having thrown in 110g and 71g (it being about 2Eq as an epoxy group to 1Eq of carboxyl groups of non-solvent mold laurylacrylate / acrylic-acid copolymer) of the bisphenol A mold epoxy resins, and agitating the non-solvent mold laurylacrylate / acrylic-acid copolymer of weight average molecular weight 3100 [ about ] with nitrogen bubbling, it applied to the separable flask equipped with an agitator, a thermometer, a cooling pipe, distillate ruble, and nitrogen gas installation tubing for about 15 minutes, and the temperature up was carried out to it at 150-degreeC. After keeping it warm at this temperature for 2 hours and advancing a reaction, NMP78g was made to cool here to addition and a room temperature, and the NMP solution of about 70 % of the weight of the second resinous principle was obtained.

[0019] The NMP solution of first resinous principle 8 mass % and the NMP solution of about 70 % of the weight of the second resinous principle were mixed at a rate of 100:10 by mass conversion of each resinous principle, and the NMP solution of a thermosetting plasticization polyvinyl-alcohol-resin constituent was obtained.

[0020] The manganic acid lithium powder as a lithium manganese multiple oxide which has a spinel mold crystal structure, (Production of a positive-electrode plate) Predetermined carbon material later mentioned as electric conduction material, and polyvinylidene fluoride (PVDF) or thermosetting plasticization polyvinyl alcohol resin (it is hereafter called the thermosetting plasticization PVA.) as a binder (binder) the positive active material which mixed the NMP solution of a constituent with the predetermined mixing ratio -- the slurry which accepted the need, and added and kneaded the N-methyl-2-pyrrolidone (NMP) of a distributed solvent to the mixture was obtained. this time -- the amount of carbon material -- positive active material -- ten to 12 mass [ of a mixture ] % -- carrying out -- and the amount of a binder -- positive active material -- it considered as three to 5 mass [ of a mixture ] %. The amount of application of the manganic acid lithium per positive-electrode charge collector one side applied the produced slurry to both sides of aluminium foil (positive-electrode charge collector) with a thickness of 20 micrometers by 80 - 160 g/m<sup>2</sup>. At this time, it left the uncoated portion with a width of face of 30mm to one side edge of a positive-electrode plate longitudinal direction. after that desiccation and a press -- judging -- width of face of 82mm, predetermined die length, and positive active material -- a mixture -- the positive-electrode plate of spreading section predetermined thickness was obtained. Bulk density of a positive-active-material binder layer was made into 2.65 g/cm<sup>3</sup>. Notching was put into the above-mentioned uncoated portion, and the notching remainder was made into the piece of a positive-electrode lead. The adjacent piece of a positive-electrode lead was made into 50mm spacing, and width of face of the piece of a positive-electrode lead was set to 5mm.

[0021] The graphite powder by Osaka Gas chemical incorporated company which is mesophase system nodular graphite as a negative-electrode active material (Production of a negative-electrode plate) (It is hereafter called MCMB.) Or amorphous carbon powder by Kureha Chemical Industry Co., Ltd. which is amorphous carbon (trade name carbo TRON P) (it is hereafter called PIC.) In 92 mass sections, PVDF of 8 mass sections, or the negative-electrode active material added so that it might become 8 mass sections by making the NMP solution of the thermosetting plasticization PVA into a pitch -- the slurry which accepted the need, and added and kneaded NMP of a distributed solvent to the mixture was applied to both sides of rolling copper foil (negative-electrode charge collector) with a thickness of 10

micrometers. At this time, it left the uncoated portion with a width of face of 30mm to one side edge of a negative-electrode plate longitudinal direction. after that desiccation and a press -- judging -- width of face of 86mm, predetermined die length, and a negative-electrode active material -- a mixture -- the negative-electrode plate of spreading section predetermined thickness was obtained. The negative-electrode plate was compressed so that the voidage of a negative-electrode active material binder layer became about 35%. After this, in order to carry out heat curing of the negative electrode which used the thermosetting plasticization PVA for the binder, it performed the vacuum drying and heat treatment of 16 hours by 150-degreeC. Notching was put into the above-mentioned uncoated portion like the positive electrode, and the notching remainder was made into the piece of a negative-electrode lead. The adjacent piece of a negative-electrode lead was made into 50mm spacing, and width of face of the piece of a negative-electrode lead was set to 5mm.

[0022] Moreover, by the winding most inner circumference, when it wound so that it may mention later, the produced electrode plate made the die length of a negative-electrode plate longer 12cm than the die length of a positive-electrode plate so that a positive-electrode plate might not overflow a negative-electrode plate in the winding direction and a positive-electrode plate might not overflow a negative-electrode plate in the winding direction by the outermost periphery. moreover, the winding direction and a perpendicular direction -- also setting -- positive active material -- a mixture -- the spreading section -- a negative-electrode active material -- a mixture -- it does not begin to see from the spreading section -- as -- a negative-electrode active material -- a mixture -- the width of face of the spreading section -- positive active material -- a mixture -- it was made longer 4mm than the width of face of the spreading section.

[0023] (Production of a cell) As shown in drawing 1, the positive-electrode plate and negative-electrode plate which carried out [ above-mentioned ] production were wound with the separator W5 made from polyethylene with a width of face [ of 90mm ], and a thickness of 40 micrometers so that these two-poles plate might not contact directly. The bell shape axis 1 made from polypropylene was used for the core of winding. this time -- the piece of a positive-electrode lead, and the piece of a negative-electrode lead -- respectively -- the winding group (electrode winding group) 6 -- it was made to be mutually located in the both-ends side of the opposite side Moreover, the die length of a positive-electrode plate, a negative-electrode plate, and a separator was adjusted, and the diameter of the winding group 6 was set to  $38 \pm 0.1$ mm.

[0024] The piece of a positive-electrode lead was made to transform, after gathering and contacting the all near the flange peripheral surface jutted over one out of the perimeter of the positive-electrode current collection ring of the axis 1 of the winding group 6 which is on a production mostly, ultrasonic welding of the piece of a positive-electrode lead and the flange peripheral surface was carried out, and the piece of a positive-electrode lead was connected to the flange peripheral surface. On the other hand, dialing operation of a negative-electrode current collection ring and the piece of a negative-electrode lead as well as the dialing operation of a positive-electrode current collection ring and the piece of a positive-electrode lead was carried out.

[0025] Then, pre-insulation was performed to the flange peripheral surface perimeter of a positive-electrode current collection ring. The adhesive tape with which the base material applied the binder which becomes that one side from hexa methacrylate with polyimide was used for this pre-insulation. Winding group 6 peripheral face was covered from the flange peripheral surface, this adhesive tape was rolled more than one layer, and it considered as pre-insulation, and inserted into the cell container 7. made from the steel with which the winding group 6 was given to nickel plating. The outer diameter of the cell container 7 is 40mm, and a bore is 39mm.

[0026] The negative-electrode lead plate for an electric flow is beforehand welded to the negative-electrode current collection ring, and the pars basilaris ossis occipitalis and negative-electrode lead plate of the cell container 7 were welded after inserting the winding group 6 in the cell container 7.

[0027] On the other hand, the positive-electrode lead which piled up and constituted the ribbon made from aluminum of two or more sheets beforehand is welded to the positive-electrode current collection ring, and the other end of a positive-electrode lead was welded to the inferior surface of tongue of the



cell lid for obturating the cell container 7. The cleavage valve 11 as an internal pressure disconnection device which cleaves according to an internal pressure rise of the cylindrical shape lithium ion battery 20 is formed in the cell lid. \*\*\*\*\* of the cleavage valve 11 was set as about  $9 \times 10^5$  Pa. The cell lid consists of a lid case, a valve guard which maintains an airtight, and a cleavage valve (internal gas exhaust valve) 11, the laminating of these is carried out and caulking \*\*\*\*\* assembles the periphery of a lid case.

[0028] Nonaqueous electrolyte was poured in into the specified quantity cell container 7, and the cylindrical shape lithium ion battery 20 was completed after that by covering the cell container 7 with a cell lid, as a positive-electrode lead is folded up, and carrying out caulking \*\*\*\*\* through the gasket made of EPDM resin.

[0029] What dissolved one mol ( $\text{LiPF}_6$ ) /of 6 phosphorus-fluoride acid lithiums 1. into the mixed solution of the volume ratio 1:1:1 of ethylene carbonate, dimethyl carbonate, and diethyl carbonate was used for nonaqueous electrolyte. In addition, for example, it operates electrically according to the rise of cell temperature, neither the PTC (Positive Temperature Coefficient) component nor the current cutoff device in which the electric lead of a positive electrode or a negative electrode is cut according to the rise of cell internal pressure is prepared in the cylindrical shape lithium ion battery 20.

[0030] the positive active material which includes the manganic acid lithium, the carbon material and PVDF which have a spinel mold crystal structure, and the thermosetting plasticization PVA according to this operation gestalt -- the lithium ion battery of high capacity and high power is securable by using the positive electrode which applied the mixture, and the negative electrode which used as the negative-electrode active material the graphite powder which can emit [ occlusion and ] a lithium ion, or amorphous carbon powder by charge and discharge. the amount of application of a manganic acid lithium -- per positive-electrode charge collector one side -- 80 - 160 g/m<sup>2</sup> -- carrying out -- and the amount of carbon material -- positive active material -- by considering as ten to 12 mass [ of a mixture ] % nonaqueous electrolyte and positive active material -- since the calorific value accompanying a chemical reaction with a mixture can be reduced and a lot of [ rapid and ] generation of gas within the cylindrical shape lithium ion battery 20 can be controlled, the gas evolution from the cleavage valve 11 prepared in order to prevent an internal pressure rise of a cell is performed very quietly. furthermore, the amount of PVDF(s) -- positive active material -- considering as three to 5 mass [ of a mixture ] % -- positive active material -- since exfoliation and omission of a mixture can be prevented, an early capacity and the fall of an output can be controlled. Therefore, the produced cylindrical shape lithium ion battery 20 is a cell with very high safety, though it is high capacity and high power.

[0031]

[Example] Next, the example of the cylindrical shape lithium ion battery 20 produced according to this operation gestalt is explained. In addition, it writes together also about the cell of the example of a comparison produced for the comparison.

[0032] As shown in the following table 1, (Example 1) In the example 1 The atomic ratio (Li/Mn ratio) 0.52 of Li and Mn, the manganic acid lithium ( $\text{Li}_{1+x}\text{Mn}_{2-x}\text{O}_4$ ) powder of about 20 micrometers of mean diameters, a scale-like graphite with a mean particle diameter of 18 micrometers and the compounding ratio of PVDF -- mass % -- 85:11:4 -- carrying out -- the amount of application of the manganic acid lithium per aluminium foil one side -- 80 g/m<sup>2</sup> and positive active material -- a mixture -- the thickness (the thickness of aluminium foil is not included.) of the spreading section (It is hereafter called positive-electrode spreading section thickness.) The die length of 71 micrometers and a positive-electrode plate was set to 438cm. The mean diameter of a scale-like graphite is 0.9 times to the mean diameter of a manganic acid lithium. MCMB which is mesophase system nodular graphite at a negative-electrode active material -- a negative-electrode binder -- PVDF -- using -- a negative-electrode active material -- a mixture -- the die length of 53 micrometers and a negative-electrode plate was set to 450cm for the thickness (the thickness of copper foil is not included.) (henceforth negative-electrode spreading section thickness) of the spreading section. In addition, the mean particle diameter of a scale-like graphite can be sifted out and a classification can adjust it (the following, as long as it is unstated, also in an example and the example of a comparison, it is the same.).



[0033]

[Table 1]

	正										負				
	Li/Mn 比	x	y	M	塗着量 (g/m <sup>2</sup> )	厚さ (μm)	長さ (cm)	ハインダ量 (質量%)	導電		材	活物 質	厚さ (μm)	長さ (cm)	
									量 (質量%)	材質					質量 比
実施例 1	0.52	0.0263	-	-	80	71	438	4	11	黒鉛	-	0.9	MCMB	53	450
実施例 2	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 2-a	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 2-b	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 2-c	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 2-d	0.52	0.0263	-	-	120	106	345	3	11	黒鉛	-	0.9	MCMB	80	357
実施例 2-e	0.52	0.0263	-	-	120	108	343	6	11	黒鉛	-	0.9	MCMB	80	355
実施例 2-f	0.55	0.0645	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 2-g	0.58	0.1013	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 2-h	0.60	0.1250	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 2-i	0.61	0.1366	-	-	120	107	345	4	11	黒鉛	-	0.9	MCMB	79	357
実施例 3	0.52	0.0263	-	-	150	142	284	4	11	黒鉛	-	0.9	MCMB	106	296
実施例 4	0.52	0.0263	-	-	120	105	347	6	8	黒鉛	-	0.9	MCMB	79	359
実施例 5	0.52	0.0263	-	-	120	108	343	4	12	黒鉛	-	0.9	MCMB	80	356
実施例 6	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	75:25	0.9	MCMB	79	357
実施例 6-a	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	75:26	0.9	MCMB	79	357
実施例 6-b	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	75:25	0.9	MCMB	79	357
実施例 6-c	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	75:25	0.9	MCMB	79	357

[0034] (Example 2) As shown in Table 1, in the example 2, the amount of application of a manganic acid lithium was made into 120 g/m<sup>2</sup>, and positive-electrode spreading section thickness was made to be the same as that of an example 1 except having set [ the die length of 107 micrometers and a positive-electrode plate ] the die length of 79 micrometers and a negative-electrode plate to 357cm for 345cm and negative-electrode spreading section thickness.

[0035] (Example 2-I) As shown in Table 1, in example 2-I, the cell was produced like the example 2 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0036] (Example 2-RO) As shown in Table 1, in example 2-RO, the cell was produced like the example 2 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0037] (Example 2-Ha) As shown in Table 1, in example 2-Ha, the cell was produced like the example 2 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0038] (Example 2-a) As shown in Table 1, in example 2-a, manganic acid lithium powder, the scale-like graphite, and the compounding ratio of PVDF were set to 86:11:3, and positive-electrode spreading section thickness was made to be the same as that of an example 2 except having set 106 micrometers and negative-electrode spreading section thickness to 80 micrometers.

[0039] (Example 2-b) As shown in Table 1, in example 2-b, manganic acid lithium powder, the scale-like graphite, and the compounding ratio of PVDF were set to 84:11:5, and positive-electrode spreading section thickness was made to be the same as that of an example 2 except having set [ the die length of 108 micrometers and a positive-electrode plate ] the die length of 80 micrometers and a negative-electrode plate to 355cm for 343cm and negative-electrode spreading section thickness.

[0040] (Example 2-2 to 2-5) As shown in Table 1, in the example 2-2 - the example 2-5, it was made to be the same as that of an example 2 except having been referred to as 0.55 in the example 2-2, having been referred to as 0.58 in the example 2-3, having set the Li/Mn ratio of a manganic acid lithium to 0.60 in the example 2-4, and having set it to 0.61 in the example 2-5.

[0041] (Example 3) As shown in Table 1, in the example 3, the amount of application of a manganic acid lithium was made into 160 g/m<sup>2</sup>, and positive-electrode spreading section thickness was made to be the same as that of an example 1 except having set [ the die length of 142 micrometers and a positive-electrode plate ] the die length of 106 micrometers and a negative-electrode plate to 296cm for 284cm and negative-electrode spreading section thickness.

[0042] (Example 4) As shown in Table 1, in the example 4, manganic acid lithium powder, the scale-like graphite, and the compounding ratio of PVDF were set to 87:8:5, the die length of 105 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 347cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 79 micrometers and a negative-electrode plate to 359cm.

[0043] (Example 5) As shown in Table 1, in the example 5, manganic acid lithium powder, the scale-like graphite, and the compounding ratio of PVDF were set to 84:12:4, the die length of 108 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 343cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 80 micrometers and a negative-electrode plate to 355cm.

[0044] As shown in Table 1, (Example 6) In the example 6 It is the KETCHIEN black (it is hereafter called KB.) of a scale-like graphite and amorphous carbon as carbon material. The compounding ratio of manganic acid lithium powder, a scale-like graphite, KB, and PVDF is set to 85:8.25:2.75:4 using mixture. The die length of 107 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 345cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 79 micrometers and a negative-electrode plate to 357cm. The sum total loadings of a graphite and KB are 11 mass %, and the mass ratio of a graphite and KB is 75:25.

[0045] (Example 6-I) As shown in Table 1, in example 6-I, the cell was produced like the example 6 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0046] (Example 6-RO) As shown in Table 1, in example 6-RO, the cell was produced like the example 6 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0047] (Example 6-Ha) As shown in Table 1, in example 6-Ha, the cell was produced like the example 6 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0048] (An example 6-1 - example 6-4) As shown in the following table 2, in the example 6-1 - the example 6-4, it was made to be the same as that of an example 6 except having changed the compounding ratio of manganic acid lithium powder, a scale-like graphite, KB, and PVDF. The compounding ratio was set to 85:8.8:2.2:4 (the mass ratio of a graphite and KB is 80:20) in the example 6-1, was set to 85:9.35:1.65:4 (the mass ratio of a graphite and KB is 85:15) in the example 6-2, was set to 85:9.9:1.1:4 (the mass ratio of a graphite and KB is 90:10) in the example 6-3, and was set to 85:10.45:0.55:4 (the mass ratio of a graphite and KB is 95:5) in the example 6-4.

[0049]

[Table 2]

	正極										負極				
	Li/Mn 比	x	y	M	塗着量 (g/m <sup>2</sup> )	厚さ (μm)	長さ (cm)	パインダ量 (質量%)	導電材			活物質	厚さ (μm)	長さ (cm)	
									量 (質量%)	材質	質量 比				黒鉛粒徑 (対Mn)
実施例 6-1	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	80:20	0.9	MCMB	79	357
実施例 6-2	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.9	MCMB	79	357
実施例 6-2-1	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.9	MCMB	79	357
実施例 6-2-2	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.9	MCMB	79	357
実施例 6-2-3	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.9	MCMB	79	357
実施例 6-2-4	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.9	MCMB	79	357
実施例 6-3	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	90:10	0.9	MCMB	79	357
実施例 6-4	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	95:5	0.9	MCMB	79	357
実施例 7	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.1	MCMB	79	357
実施例 8	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.2	MCMB	79	357
実施例 9	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.5	MCMB	79	357
実施例 9-1	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.5	MCMB	79	357
実施例 9-2	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.5	MCMB	79	357
実施例 9-3	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.5	MCMB	79	357
実施例 9-4	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.5	MCMB	79	357
実施例 10	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/KB	85:15	0.8	MCMB	79	357
実施例 11	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 11-1	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 11-2	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 11-3	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 11-4	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357

[0050] (Example 6-2-I) As shown in Table 2, in example 6-2-I, the cell was produced like the example

6-2 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0051] (Example 6-2-RO) As shown in Table 2, in example 6-2-RO, the cell was produced like the example 6-2 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0052] (Example 6-2-Ha) As shown in Table 2, in example 6-2-Ha, the cell was produced like the example 6-2 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0053] (Example 7) As shown in Table 2, in the example 7, it was made to be the same as that of an example 6 using the scale-like graphite with a mean particle diameter of 2 micrometers except having set the compounding ratio of manganic acid lithium powder, a scale-like graphite, KB, and PVDF to 85:9.35:1.65:4 (the mass ratio of a graphite and KB being 85:15). The mean diameter of a scale-like graphite is 0.1 times to the mean diameter of a manganic acid lithium.

[0054] (An example 8 - example 10) As shown in Table 2, in the example 8 - the example 10, it was made to be the same as that of an example 7 except having used the scale-like graphite with which mean particle diameter differs. In the example 8, the scale-like graphite (they are 0.8 times to the mean diameter of a manganic acid lithium) of 16 micrometers of mean diameters was used in the example 10 by the example 9 using the scale-like graphite (they are 0.5 times to the mean diameter of a manganic acid lithium) of 10 micrometers of mean diameters using the scale-like graphite (they are 0.2 times to the mean diameter of a manganic acid lithium) of 4 micrometers of mean diameters.

[0055] (Example 9-I) As shown in Table 2, in example 9-I, the cell was produced like the example 9 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0056] (Example 9-RO) As shown in Table 2, in example 9-RO, the cell was produced like the example 9 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0057] (Example 9-Ha) As shown in Table 2, in example 9-Ha, the cell was produced like the example 9 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0058] As shown in the following table 2, (Example 11) In the example 11 It is acetylene black (it is hereafter called AB.) of a scale-like graphite and amorphous carbon as carbon material. Mixture is used. Manganic acid lithium powder, the scale-like graphite of 10 micrometers of mean diameters (they are 0.5 times to the mean diameter of a manganic acid lithium), The compounding ratio of AB and PVDF is set to 85:9.35:1.65:4 (the mass ratio of a graphite and AB is 85:15). It was made to be the same as that of an example 1 except having set 120 g/m<sup>2</sup> and positive-electrode spreading section thickness to 107 micrometers, having set die length to 345cm for the amount of application of a manganic acid lithium, having set negative-electrode spreading section thickness to 79 micrometers, and having set die length to 357cm.

[0059] (Example 11-I) As shown in Table 2, in example 11-I, the cell was produced like the example 11 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0060] (Example 11-RO) As shown in Table 2, in example 11-RO, the cell was produced like the example 11 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0061] (Example 11-Ha) As shown in Table 2, in example 11-Ha, the cell was produced like the example 11 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0062] (An example 12 - example 15) As shown in the following table 3, in the example 12 - the example 15, it was made to be the same as that of an example 11 except having been referred to as 0.55 in the example 12, having been referred to as 0.58 in the example 13, having set the Li/Mn ratio of a manganic acid lithium to 0.60 in the example 14, and having set it to 0.61 in the example 15.

[0063]

[Table 3]

	正										負				
	Li/Mn 比	x	y	M	塗着量 (g/m <sup>2</sup> )	厚さ (μm)	長さ (cm)	ハッチング量 (質量%)	導電材			活物質	厚さ (μm)	長さ (cm)	
									量 (質量%)	材質	質量比				
実施例 12	0.55	0.0645	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 13	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 13-I	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 13-II	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 13-A	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 14	0.60	0.1250	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15	0.61	0.1366	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-A		0.0100	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-B		0.0400	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-C		0.1000	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-D		0.1100	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-E		0.0400	0.01	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-F		0.0400	0.30	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-G		0.0400	0.33	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-H		0.0400	0.20	Al	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-I		0.0400	0.20	Ni	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357

[0064] (Example 13-I) As shown in Table 3, in example 13-I, the cell was produced like the example 13 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0065] (Example 13-RO) As shown in Table 3, in example 13-RO, the cell was produced like the example 13 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0066] (Example 13-Ha) As shown in Table 3, in example 13-Ha, the cell was produced like the example 13 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0067] (Example 15-A - example 15-N) As shown in Table 3 and the following table 4, in example 15-A - example 15-N, it was made to be the same as that of an example 11 except having used the manganic acid lithium ( $\text{Li}_{1+x}\text{Mn}_{2-x-y}\text{MyO}_4$ ) powder of about 20 micrometers of mean diameters which permuted some manganese atoms by other metallic elements M. In example 15-A,  $\text{Li}_{1.01}\text{Mn}_{1.79}\text{Cr}_{0.2}\text{O}_4$  is used. In example 15-B,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{Cr}_{0.2}\text{O}_4$  is used. At example 15-C,  $\text{Li}_{1.11}\text{Mn}_{1.69}\text{Cr}_{0.2}\text{O}_4$  is used by example 15-D using  $\text{Li}_{1.1}\text{Mn}_{1.7}\text{Cr}_{0.2}\text{O}_4$ . In example 15-E,  $\text{Li}_{1.04}\text{Mn}_{1.95}\text{Cr}_{0.01}\text{O}_4$  is used. In example 15-F,  $\text{Li}_{1.04}\text{Mn}_{1.66}\text{Cr}_{0.3}\text{O}_4$  is used. In example 15-G,  $\text{Li}_{1.04}\text{Mn}_{1.63}\text{Cr}_{0.33}\text{O}_4$  is used. In example 15-H,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{aluminum}_{0.2}\text{O}_4$  is used. In example 15-I,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{nickel}_{0.2}\text{O}_4$  is used. In example 15-J,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{Co}_{0.2}\text{O}_4$  is used. In example 15-K,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{Mg}_{0.2}\text{O}_4$  is used. At example 15-L,  $\text{Li}_{1.04}\text{Mn}_{1.76}(\text{CoMg})_{0.2}\text{O}_4$  were used by example 15-N using  $\text{Li}_{1.04}\text{Mn}_{1.76}(\text{CrMg})_{0.2}\text{O}_4$  using  $\text{Li}_{1.04}\text{Mn}_{1.76}(\text{AlCr})_{0.2}\text{O}_4$  by example 15-M. In addition, the carbonate of the metallic element M which permutes the manganic acid lithium of an element permutation mold by the manganese dioxide, It can mix so that it may become the element ratio of a request of a nitrate, a hydroxide, etc., and it can prepare by calcinating about [ 800 degrees C-900 degrees ] by C in air. After dissolving in a hydrochloric acid etc., it can ask for the element ratio in the obtained element permutation mold manganic acid lithium by the quantitative analysis by instrumental analyses, such as a titrimetric method and atomic absorption, and ICP.

[0068]

[Table 4]



	正										負				
	Li/Mn 比	x	y	M	塗着量 (g/m <sup>2</sup> )	厚さ (μm)	長さ (cm)	n <sup>+</sup> イオン量 (質量%)	導電			材	活物 質	厚さ (μm)	長さ (cm)
									量 (質量%)	材質	質量 比				
実施例 15-J		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-J-I		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-J-II		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-J-III		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-K		0.0400	0.20	Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-L		0.0400	0.20	Al, Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-M		0.0400	0.20	Cr, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-N		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-N-I		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-N-II		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 15-N-III		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	MCMB	79	357
実施例 16	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-I	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-II	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-III	0.52	0.0263	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-2	0.55	0.0400	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-3	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-3-I	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-3-II	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-3-III	0.58	0.1013	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-4	0.60	0.0400	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357
実施例 16-5	0.61	0.0400	-	-	120	107	345	4	11	黒鉛/AB	85:15	0.5	PIC	79	357

[0069] (Example 15-J-I) As shown in Table 4, in example 15-J-I, the cell was produced like example

15-J except having used the thermosetting plasticization PVA for the positive-electrode binder.  
 [0070] (Example 15-J-RO) As shown in Table 4, in example 15-J-RO, the cell was produced like example 15-J except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0071] (Example 15-J-Ha) As shown in Table 4, in example 15-J-Ha, the cell was produced like example 15-J except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0072] (Example 15-N-I) As shown in Table 4, in example 15-N-I, the cell was produced like example 15-N except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0073] (Example 15-N-RO) As shown in Table 4, in example 15-N-RO, the cell was produced like example 15-N except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0074] (Example 15-N-Ha) As shown in Table 4, in example 15-N-Ha, the cell was produced like example 15-N except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0075] (Example 16) As shown in Table 4, in the example 16, it was made to be the same as that of an example 11 except having used PIC which is amorphous carbon as a negative-electrode active material.

[0076] (Example 16-I) As shown in Table 4, in example 16-I, the cell was produced like the example 16 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0077] (Example 16-RO) As shown in Table 4, in example 16-RO, the cell was produced like the example 16 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0078] (Example 16-Ha) As shown in Table 4, in example 16-Ha, the cell was produced like the example 16 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0079] (Example 16-2 to 16-5) As shown in Table 4, in the example 16-2 - the example 16-5, it was made to be the same as that of an example 16 except having been referred to as 0.55 in the example 16-2, having been referred to as 0.58 in the example 16-3, having set the Li/Mn ratio of a manganic acid lithium to 0.60 in the example 16-4, and having set it to 0.61 in the example 16-5.

[0080] (Example 16-3-I) As shown in Table 4, in example 16-3-I, the cell was produced like the example 16-3 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0081] (Example 16-3-RO) As shown in Table 4, in example 16-3-RO, the cell was produced like the example 16-3 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0082] (Example 16-3-Ha) As shown in Table 4, in example 16-3-Ha, the cell was produced like the example 16-3 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0083] (Example 16-A - example 16-N) As shown in the following table 5, in example 16-A - example 16-N, it was made to be the same as that of an example 16 except having used the manganic acid lithium ( $\text{Li}_{1+x}\text{Mn}_{2-x-y}\text{MyO}_4$ ) powder of about 20 micrometers of mean diameters which permuted some manganese atoms by other metallic elements M. In example 16-A,  $\text{Li}_{1.01}\text{Mn}_{1.79}\text{Cr}_{0.2}\text{O}_4$  is used. In example 16-B,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{Cr}_{0.2}\text{O}_4$  is used. At example 16-C,  $\text{Li}_{1.11}\text{Mn}_{1.69}\text{Cr}_{0.2}\text{O}_4$  is used by example 16-D using  $\text{Li}_{1.1}\text{Mn}_{1.7}\text{Cr}_{0.2}\text{O}_4$ . In example 16-E,  $\text{Li}_{1.04}\text{Mn}_{1.95}\text{Cr}_{0.01}\text{O}_4$  is used. In example 16-F,  $\text{Li}_{1.04}\text{Mn}_{1.66}\text{Cr}_{0.3}\text{O}_4$  is used. In example 16-G,  $\text{Li}_{1.04}\text{Mn}_{1.63}\text{Cr}_{0.33}\text{O}_4$  is used. In example 16-H,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{aluminum}_{0.2}\text{O}_4$  is used. In example 16-I,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{nickel}_{0.2}\text{O}_4$  is used. In example 16-J,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{Co}_{0.2}\text{O}_4$  is used. In example 16-K,  $\text{Li}_{1.04}\text{Mn}_{1.76}\text{Mg}_{0.2}\text{O}_4$  is used. At example 16-L,  $\text{Li}_{1.04}\text{Mn}_{1.76}(\text{CoMg})_{0.2}\text{O}_4$  were used by example 16-N using  $\text{Li}_{1.04}\text{Mn}_{1.76}(\text{CrMg})_{0.2}\text{O}_4$  using  $\text{Li}_{1.04}\text{Mn}_{1.76}(\text{AlCr})_{0.2}\text{O}_4$  by example 16-M.

[0084]

[Table 5].

	正										負			
	Li/Mn 比	x	y	M	塗着量 (g/m <sup>2</sup> )	厚さ (μm)	長さ (cm)	入イオン 量 (質量%)	導電		活 物 質	厚さ (μm)	長さ (cm)	
									量 (質量%)	材質				質量 比
実施例 16-A	0.52	0.0263	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-B	0.55	0.0645	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-C	0.58	0.1013	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-D	0.60	0.1250	0.20	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-E	0.61	0.1366	0.01	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-F		0.0100	0.30	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-G		0.0400	0.33	Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-H		0.1000	0.20	Al	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-I		0.1100	0.20	Ni	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-J		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-J-I		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-J-II		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-J-III		0.0400	0.20	Co	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-K		0.0400	0.20	Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-L		0.0400	0.20	Al, Cr	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-M		0.0400	0.20	Cr, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-N		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-N-I		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-N-II		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357
実施例 16-N-III		0.0400	0.20	Co, Mg	120	107	345	4	11	黒鉛/AB	85:15	0.5	79	357

[0085] (Example 16-J-I) As shown in Table 5, in example 16-J-I, the cell was produced like example

16-J except having used the thermosetting plasticization PVA for the positive-electrode binder.  
[0086] (Example 16-J-RO) As shown in Table 5, in example 16-J-RO, the cell was produced like example 16-J except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0087] (Example 16-J-Ha) As shown in Table 5, in example 16-J-Ha, the cell was produced like example 16-J except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0088] (Example 16-N-I) As shown in Table 5, in example 16-N-I, the cell was produced like example 16-N except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0089] (Example 16-N-RO) As shown in the real table 5, in example of \*\* 16-N-RO, the cell was produced like example 16-N except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0090] (Example 16-N-Ha) As shown in Table 5, in example 16-N-Ha, the cell was produced like example 16-N except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0091] As shown in the following table 6, (Example 17) In the example 17 The scale-like graphite (they are 0.5 times to the mean diameter of a manganic acid lithium) of 10 micrometers of mean diameters is used for carbon material. The die length of 107 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 345cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 at the negative-electrode active material using PIC except having set the die length of 79 micrometers and a negative-electrode plate to 357cm.

[0092]

[Table 6]

	正極										負極				
	Li/Mn 比	x	y	M	塗着量 (g/m <sup>2</sup> )	厚さ (μm)	長さ (cm)	ハインダ量 (質量%)	導電材			活物質	厚さ (μm)	長さ (cm)	
									量 (質量%)	材質	質量 比				黒鉛粒徑 (対Mn)
実施例 17	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-1	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-2	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-3	0.52	0.0263	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-4	0.55	0.0645	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-5	0.58	0.1013	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-6	0.58	0.1013	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-7	0.58	0.1013	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-8	0.58	0.1013	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-9	0.58	0.1013	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-10	0.60	0.1250	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
実施例 17-11	0.61	0.1366	-	-	120	107	345	4	11	黒鉛	-	0.5	PIC	79	357
比較例 1	0.52	0.0263	-	-	75	67	453	4	11	黒鉛	-	0.9	MCMB	50	465
比較例 2	0.52	0.0263	-	-	165	146	278	4	11	黒鉛	-	0.9	MCMB	109	290
比較例 2-a	0.52	0.0263	-	-	120	105	347	2.5	11	黒鉛	-	0.9	MCMB	79	359
比較例 2-b	0.52	0.0263	-	-	120	109	342	6	11	黒鉛	-	0.9	MCMB	79	354
比較例 3	0.52	0.0263	-	-	120	104	348	4	9	黒鉛	-	0.9	MCMB	79	360
比較例 4	0.52	0.0263	-	-	120	109	342	4	13	黒鉛	-	0.9	MCMB	79	354

[0093] (Example 17-I) As shown in Table 6, in example 17-I, the cell was produced like the example 17 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0094] (Example 17-RO) As shown in Table 6, in example 17-RO, the cell was produced like the example 17 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0095] (Example 17-Ha) As shown in Table 6, in example 17-Ha, the cell was produced like the example 17 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0096] (Example 17-2 to 17-5) As shown in Table 6, in the example 17-2 - the example 17-5, it was made to be the same as that of an example 17 except having been referred to as 0.55 in the example 17-2, having been referred to as 0.58 in the example 17-3, having set the Li/Mn ratio of a manganic acid lithium to 0.60 in the example 17-4, and having set it to 0.61 in the example 17-5.

[0097] (Example 17-3-I) As shown in Table 6, in example 17-3-I, the cell was produced like the example 17-3 except having used the thermosetting plasticization PVA for the positive-electrode binder.

[0098] (Example 17-3-RO) As shown in Table 6, in example 17-3-RO, the cell was produced like the example 17-3 except having used the thermosetting plasticization PVA for the negative-electrode binder.

[0099] (Example 17-3-Ha) As shown in Table 6, in example 17-3-Ha, the cell was produced like the example 17-3 except having used the thermosetting plasticization PVA for the positive electrode and the negative-electrode binder.

[0100] (Example 1 of a comparison) As shown in Table 6, in the example 1 of a comparison, the amount of application of a manganic acid lithium was made into 75 g/m<sup>2</sup>, the die length of 67 micrometers and a positive-electrode plate was set to 453cm for positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 50 micrometers and a negative-electrode plate to 465cm.

[0101] (Example 2 of a comparison) As shown in Table 6, in the example 2 of a comparison, the amount of application of a manganic acid lithium was made into 165 g/m<sup>2</sup>, the die length of 146 micrometers and a positive-electrode plate was set to 278cm for positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 109 micrometers and a negative-electrode plate to 290cm.

[0102] As shown in Table 6, (Example of comparison 2-a) In example of comparison 2-a Manganic acid lithium powder, a scale-like graphite, and the compounding ratio of PVDF are set to 86.5:11:2.5. The die length of 105 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 347cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 79 micrometers and a negative-electrode plate to 359cm.

[0103] As shown in Table 6, (Example of comparison 2-b) In example of comparison 2-b Manganic acid lithium powder, a scale-like graphite, and the compounding ratio of PVDF are set to 83:11:6. The die length of 109 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 342cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 79 micrometers and a negative-electrode plate to 354cm.

[0104] (Example 3 of a comparison) As shown in Table 6, in the example 3 of a comparison, manganic acid lithium powder, the scale-like graphite, and the compounding ratio of PVDF were set to 87:9:4, the die length of 104 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 348cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except having set the die length of 79 micrometers and a negative-electrode plate to 360cm.

[0105] (Example 4 of a comparison) As shown in Table 6, in the example 4 of a comparison, manganic acid lithium powder, the scale-like graphite, and the compounding ratio of PVDF were set to 83:13:4, the die length of 109 micrometers and a positive-electrode plate was set [ the amount of application of a manganic acid lithium ] to 342cm for 120 g/m<sup>2</sup> and positive-electrode spreading section thickness, and negative-electrode spreading section thickness was made to be the same as that of an example 1 except

having set the die length of 79 micrometers and a negative-electrode plate to 354cm.

[0106] A series of following trials were performed about each cell of <a trial and evaluation> next the example produced as mentioned above, and the example of a comparison.

[0107] The afterdischarge of each cell of an example and the example of a comparison was charged and carried out, and discharge capacity was measured. Charge conditions were made into 4.2V constant voltage, limit current 5A, and 3.5 hours. Discharge conditions were set to 5A constant current and termination electrical-potential-difference 2.7V.

[0108] Moreover, the discharge output of the cell of a charge condition was measured on the above-mentioned conditions. The Measuring condition read the electrical potential difference for the 5th second by 1A, 3A, 6A, and each discharge current, and plotted it on the axis of ordinate to the axis-of-abscissa current value, and the approximation straight line which connects three points considered the current value which intersects 2.7V, and the product of 2.7V as the output.

[0109] Furthermore, after repeating charge and discharge for each cell of an example and the example of a comparison 100 times on the above-mentioned conditions, the output was measured and the percentage showed the maintenance factor to an early output. A life property will have the good one with a natural thing where this maintenance factor is higher.

[0110] Furthermore, succeedingly, about the cell of an example, except having set perimeter environmental temperature of a cell to 60-degreeC, after repeating charge and discharge 100 times on these conditions, after the cell returned to the room temperature (25 \*\*1-degreeC) enough, the output was measured, and the percentage showed the maintenance factor to an early output.

[0111] As long as there was no special mention, all performed measurement of these charge, discharge, and an output in the ambient atmosphere of environmental temperature 25 \*\*1-degreeC.

[0112] Then, continuation charge of the produced cell was carried out according to 20A constant current in ordinary temperature, and cell behavior was observed. A cell will be in an abnormal condition by continuation charge, it generates heat and cell skin temperature rises. In connection with this, cell internal pressure rises, the cleavage valve 11 cleaves, and the gas inside a cell is emitted outside. In order to measure extent of this gas evolution, the cell skin temperature immediately after cleavage valve cleavage was measured. Moreover, the existence of deformation of a cell container was checked after the gas evolution. A test result is shown in the following table 7 and Table 8 and 9. In addition, in Table 7, 8, and 9, as for "O", that into which the cell container deformed greatly what deformation of a cell container was not accepted in at all, and "\*\*\*" for what deformation of the some of a cell container was accepted in, and "x" is shown.

[0113]

[Table 7]



	容量 (Ah)	出力		安全性	
		初期 (V)	維持率 (%)	電池表面 温度(℃)	電池 外觀
実施例1	5.4	770	90	220	△
実施例2	6.4	750	90	180	
実施例 2-1	6.4	750	90	180	
実施例 2-2	6.4	750	90	180	
実施例 2-3	6.4	750	91	180	
実施例2-a	6.5	750	90	180	
実施例2-b	6.4	750	90	180	
実施例2-2	6.4	750	93	180	
実施例2-3	6.3	750	94	180	
実施例2-4	6.3	750	95	180	
実施例2-6	5.8	750	95	180	
実施例3	7.0	710	90	150	
実施例4	6.5	715	88	170	
実施例5	6.4	730	92	190	
実施例6	6.4	760	90	180	
実施例 6-1	6.4	760	90	180	
実施例 6-2	6.4	760	90	180	
実施例 6-3	6.4	760	91	180	
実施例6-1	6.4	770	90	180	
実施例6-2	6.4	770	90	180	
実施例 6-2-1	6.4	770	90	180	
実施例 6-2-2	6.4	770	90	180	
実施例 6-2-3	6.4	770	91	180	
実施例6-3	6.4	770	90	180	
実施例6-4	6.4	760	85	180	
実施例7	6.4	780	90	210	△
実施例8	6.4	780	90	190	
実施例9	6.4	770	90	180	
実施例 9-1	6.4	770	90	180	
実施例 9-2	6.4	770	90	180	
実施例 9-3	6.4	770	91	180	
実施例10	6.4	770	90	170	
実施例11	6.4	800	91	180	
実施例 11-1	6.4	800	91	180	
実施例 11-2	6.4	800	91	180	
実施例 11-3	6.4	800	92	180	
実施例12	6.4	800	94	180	
実施例13	6.3	800	95	180	
実施例 13-1	6.3	800	95	180	
実施例 13-2	6.3	800	95	180	
実施例 13-3	6.3	800	96	180	
実施例14	6.3	800	96	180	

[0114]

[Table 8]

	容量 (Ah)	出力		安全性	
		初期 (W)	維持率 (%)	電池表面 温度(℃)	電池 外觀
実施例15	5.8	800	96	180	
実施例15-A	6.3	800	94	180	
実施例15-B	6.2	800	95	180	
実施例15-C	6.2	800	96	180	
実施例15-D	6.0	800	96	180	
実施例15-E	6.3	800	95	180	
実施例15-F	6.2	800	98	180	
実施例15-G	5.9	800	96	180	
実施例15-H	6.2	800	95	180	
実施例15-I	6.2	800	95	180	
実施例15-J	6.2	800	95	180	
実施例15-J-1	6.2	800	95	180	
実施例15-J-2	6.2	800	95	180	
実施例15-J-3	6.2	800	98	180	
実施例15-K	6.2	800	95	180	
実施例15-L	6.2	800	96	180	
実施例15-M	6.2	800	95	180	
実施例15-N	6.2	800	95	180	
実施例15-N-1	6.2	800	95	180	
実施例15-N-2	6.2	800	95	180	
実施例15-N-3	6.2	800	96	180	
実施例18	6.0	820	91	120	○
実施例16-1	6.0	820	91	120	○
実施例16-2	6.0	820	91	120	○
実施例16-3	6.0	820	92	120	○
実施例16-4	6.0	820	94	120	○
実施例16-5	5.9	820	95	120	○
実施例16-6	5.9	820	95	120	○
実施例16-7	5.9	820	95	120	○
実施例16-8	5.9	820	96	120	○
実施例16-9	5.9	820	96	120	○
実施例16-10	5.4	820	96	120	○

[0115]

[Table 9]

	容量 (Ah)	出力		安全性	
		初期 (V)	維持率 (%)	電池表面 温度(℃)	電池 外觀
実施例16-A	5.9	820	94	120	○
実施例16-B	5.8	820	95	120	○
実施例16-C	5.7	820	96	120	○
実施例16-D	5.6	820	96	120	○
実施例16-E	5.9	820	95	120	○
実施例16-F	5.8	820	96	120	○
実施例16-G	5.5	820	96	120	○
実施例16-H	5.8	820	95	120	○
実施例16-I	5.8	820	95	120	○
実施例16-J	5.8	820	95	120	○
実施例16-J-1	5.8	820	95	120	○
実施例16-J-2	5.8	820	95	120	○
実施例16-J-3	5.8	820	96	120	○
実施例16-K	5.8	820	95	120	○
実施例16-L	5.8	820	96	120	○
実施例16-M	5.8	820	95	120	○
実施例16-N	5.8	820	95	120	○
実施例16-N-1	5.8	820	95	120	○
実施例16-N-2	5.8	820	95	120	○
実施例16-N-3	5.8	820	96	120	○
実施例17	6.0	790	91	120	○
実施例17-1	6.0	790	91	120	○
実施例17-2	6.0	790	91	120	○
実施例17-3	6.0	790	92	120	○
実施例17-4	6.0	790	94	120	○
実施例17-5	5.9	790	95	120	○
実施例17-6	5.9	790	95	120	○
実施例17-7	5.9	790	95	120	○
実施例17-8	5.9	790	96	120	○
実施例17-9	5.9	790	96	120	○
比較例1	6.3	790	96	330	×
比較例2	7.1	630	90	150	
比較例2-a	6.5	750	79	180	
比較例2-b	6.4	660	81	160	
比較例3	6.5	645	84	150	
比較例4	6.4	740	92	310	×

[0116] As shown in Table 7, 8, and 9, the cells of an example 1 - an example 5 were high capacity and high power, and its cell behavior at the time of continuation charge was also moderate. The skin temperature of the cell at this time was 150-degree[ a maximum of ] C-220-degreeC. On the other hand, by the cell of the example 1 of a comparison by which the amount of application of a manganic acid lithium is less than 80 g/m<sup>2</sup>, although the high cell of an output maintenance factor was obtained by high power, the cell behavior at the time of continuation charge became an intense thing accompanied by deformation of a cell, and cell skin temperature was the result of exceeding 300-degreeC. Moreover, conversely, by the cell of the example 2 of a comparison by which the amount of application of a manganic acid lithium exceeds 160g/m<sup>2</sup>, although the cell behavior at the time of continuation charge was moderate, it was the result which is not suitable as a cell for electric vehicles with the fall of an output. Similarly, the cell of the example 3 of a comparison was the result of the amount of the graphite of positive-electrode electric conduction material being less than 10 mass %, and causing the fall of an output. On the other hand, although high capacity and a high power cell were obtained by the cell of the example 4 of a comparison by which the amount of the graphite of positive-electrode electric conduction material exceeds 12 mass %, the cell behavior at the time of continuation charge was an intense thing accompanied by deformation of a cell, and cell skin temperature was 310-degreeC.

[0117] The high output was able to be obtained by the cell of the example 6 - example 16-N which mixed and used a graphite and non-fixed form carbon for positive-electrode electric conduction material. In the cell of the example 6 which used KB for non-fixed form carbon - an example 10, the cell of the example 8 which made the mean diameter of a graphite 0.2 to 0.8 times to the mean diameter of a manganic acid lithium - an example 10 was a cell of high power more. On the other hand, by the cell of an example 7 by which the mean diameter of a graphite is less than 0.2 times to the mean diameter of a

manganic acid lithium, the cell skin temperature at the time of continuation charge was 210-degreeC, and was a result high a little compared with the cell of examples 8-10.

[0118] By the cell of the example 11 - example 16-N which used AB for non-fixed form carbon, high power was obtained more and it was the high cell of the output maintenance factor after 100 times charge and discharge.

[0119] The cell of example [ whose Li/Mn ratio of a manganic acid lithium is 0.55 or more ] 2-2 - example 2-5, example 12 - example 15, example 16-2 - example 16 Hajime 5, an example 17-2 - an example 17-5 was a result with a very high output maintenance factor. However, the cell of the example 2-5 in which the Li/Mn ratio of a manganic acid lithium exceeds 0.60, an example 15, an example 16-5, and an example 17-5 was as a result of the fall of capacity. Therefore, a Li/Mn ratio is understood that it is desirable to consider as the range of 0.55-0.60.

[0120] By the cell of example 15-A using the element permutation mold manganic acid lithium ( $\text{Li}_{1+x}\text{Mn}_{2-x-y}\text{MyO}_4$ ) which permuted some manganese atoms of a manganic acid lithium by other metallic elements M - example 15-N, and example 16-A - example 16-N, the output and the output maintenance factor were high, and the cell skin temperature at the time of continuation charge was also a low result. Especially, the cell of example 16-A which used PIC for the active material of a negative electrode - example 16-N had the more high output, there was no deformation of the cell at the time of continuation charge, and cell skin temperature was also a still lower result. However, the cell of example 15-D to which x exceeds 0.1, example in which is example 16-D Attained to and y exceeds 0.3 15-G, and example 16-G was a result with a capacity low a little. Therefore, as for x, it is desirable to consider as the range of  $0 < x \leq 0.1$ , and y is understood that it is desirable to consider as the range of  $0 < y \leq 0.3$ .

[0121] The cell of the example 16 which used amorphous carbon for the negative-electrode active material, an example 16-2 - an example 16-5, an example 17, an example 17-2 - an example 17-5 had an output, capacity, and a very high output maintenance factor, and there was no deformation of the cell at the time of continuation charge, and cell skin temperature was also the lowest result. Therefore, these cells are high capacity and high power, and are cells which were excellent also in safety and maintained whole balance.

[0122] The output maintenance factor after repeating a long duration charge-and-discharge cycle especially at an elevated temperature compared with the cell which used PVDF in the cell which gave "I" and "RO" to the number tail of an example which used the thermosetting plasticization PVA for the binder of a positive electrode or a negative electrode is high.

[0123] The output maintenance factor after repeating a long duration charge-and-discharge cycle especially at an elevated temperature compared with the cell which used PVDF in the cell which gave "Ha" to the number tail of an example which used the thermosetting plasticization PVA for the binder of a positive electrode and a negative electrode is still higher.

[0124] As stated above, the cylindrical shape lithium ion battery 20 of this operation gestalt The amount of application of a manganic acid lithium is made into 80 - 160 g/m<sup>2</sup> per positive-electrode charge collector one side. positive active material -- the amount of the carbon material contained in a mixture -- ten to 12 mass % -- carrying out -- and positive active material -- by making into three to 5 mass % the amount of PVDF contained in a mixture While being high capacity and high power, behavior when a cell is exposed to an unusual condition is very moderate, and is the cell excellent in safety. In this case, if mixture with a graphite, AB, or KB is used for carbon material, it can consider as the cell of high power more, and if a mass ratio with a graphite, AB, or KB is set to 80:20-90:10, it can consider as the cell of high power further. moreover, the mean diameter of a graphite -- 0.2 to 0.8 times of the mean diameter of a manganic acid lithium -- then -- more -- the cell of high power -- it can carry out -- carbon material -- the mixture of a graphite and AB -- then, it can consider as the high cell of an output maintenance factor by high power further. Furthermore, an output maintenance factor can be raised, without accompanying the Li/Mn ratio of a manganic acid lithium by 0.55-0.60, then the fall of capacity. Moreover, a manganic acid lithium is expressed with  $\text{Li}_{1+x}\text{Mn}_{2-x-y}\text{MyO}_4$ , x is  $0 < x \leq 0.1$ , y is  $0 < y \leq 0.3$ , and an output maintenance factor can be raised, without being accompanied by the manganic acid lithium of the metal replacement mold whose M is at least one sort of elements chosen

from the group of aluminum, Cr, nickel, Co, and Mg\*\*, then the fall of capacity. Furthermore, if amorphous carbon is used for the active material of a negative electrode, while being high power and high capacity, it can consider as the cell which was further excellent in safety. Thus, the cell with very high safety fits the power source for electric vehicles especially by high capacity and high power.

[0125] In addition, although illustrated with this operation gestalt about the lithium ion battery used for the power source for hybrid electric vehicles, it is not limited to the magnitude of a cell, and cell capacity, but it is checked in general to the cell of 3 - 10Ah extent as a cell capacity that this invention demonstrates effectiveness remarkably. Moreover, although illustrated about the cylindrical shape cell with this operation gestalt, this invention is not limited about the configuration of a cell, either, but can be applied also to the cell of a square shape and other polygons. Furthermore, you may be except the cell of the structure where the cylinder-like-object-with-base-like container (can) mentioned above obturates the cell top cover with caulking as a configuration which can apply this invention. The cell in the condition that a positive/negative external terminal penetrates a cell lid as an example of such structure, and the positive/negative external terminal is pushing one another through the axis within the cell container can be mentioned.

[0126] Moreover, although this operation gestalt showed the example using the adhesive tape with which the base material applied to pre-insulation with polyimide the binder which becomes from hexa methacrylate at the one side, the tape which a base material becomes from the adhesive tape which applied acrylic binders, such as hexa methacrylate and butyl acrylate, to the one side or both sides, the polyolefine which does not apply a binder, or polyimide with polyolefines, such as polypropylene and polyethylene, for example can be used suitably.

[0127] Furthermore, although what dissolved the manganic acid lithium in the positive electrode for lithium ion batteries, and dissolved one mol /of 6 phosphorus-fluoride acid lithiums in the negative electrode l. at a graphite or amorphous carbon, and the electrolytic solution into the mixed solution of the volume ratio 1:1:1 of ethylene carbonate, dimethyl carbonate, and diethyl carbonate was used with this operation gestalt, anything for which there is especially no limit in the cell of this invention, and electric conduction material and a binder (binder) are also usually used is usable. In addition, generally, although suitable lithium salt and manganese oxide can be mixed and calcinated and a manganic acid lithium can compound them, it can be made into a desired Li/Mn ratio by controlling the preparation ratio of lithium salt and manganese oxide.

[0128] moreover, as a plate active material binder for lithium ion batteries which can be used except this operation gestalt Teflon (trademark), polyethylene, polystyrene, polybutadiene, Isobutylene isoprene rubber, nitrile rubber, styrene/butadiene rubber, polysulfide rubber, Although there are polymers, these mixtures, etc., such as nitrocellulose, cyanoethyl cellulose, various latexes, acrylonitrile, and vinyl fluoride, vinylidene fluoride, and propylene fluoride, chloroprene, etc. fluoride Also after repeating an elevated-temperature charge-and-discharge cycle if thermosetting plasticization polyvinyl alcohol resin is used as this example showed, a cell with a very high output maintenance factor can be obtained.

[0129] Furthermore, the lithium manganese multiple oxide which is the ingredient in which the insertion and desorption from a lithium ion are possible as positive active material for lithium ion batteries which can be used except this operation gestalt, and inserted sufficient quantity of the lithium ion beforehand is desirable, and you may make it use the ingredient which doped elements other than manganese or a lithium during the crystal.

[0130] Furthermore, there is especially no limit in addition to the matter which also indicated the negative-electrode active material for lithium ion batteries which can be used except this operation gestalt to the above-mentioned claim again. For example, carbonaceous ingredients, such as a natural graphite, and various artificial graphite material, corks, amorphous carbon, etc. are sufficient, and it is not especially restricted [ massive / the shape of a scale a globular shape, fibrous ] in the particle shape.

[0131] Moreover, general lithium salt is used as an electrolyte as nonaqueous electrolyte, and the electrolytic solution which dissolved this in the organic solvent is used. However, especially lithium salt or the organic solvent that are used are not restricted. For example, as an electrolyte, LiC<sub>10</sub>F<sub>6</sub>, LiAsF<sub>6</sub>, LiPF<sub>6</sub>, LiBF<sub>4</sub> and LiB(C<sub>6</sub>H<sub>5</sub>)<sub>4</sub>, CH<sub>3</sub>SO<sub>3</sub>Li, CF<sub>3</sub>SO<sub>3</sub>Li(s), etc. and such mixture can be used. As a

nonaqueous electrolyte organic solvent, you may make it use these two or more kinds of mixed solvents, such as propylene carbonate, ethylene carbonate, 1, 2-dimethoxyethane, 1, 2-diethoxy ethane, gamma-butyrolactone, a tetrahydrofuran, 1, 3-dioxolane, the 4-methyl -1, 3-dioxolane, diethylether, a sulfolane, a methyl sulfolane, an acetonitrile, and propionitrile, and it is not limited about a mixed compounding ratio, either.

[0132]

[Effect of the Invention] Since the negative electrode which can emit [ occlusion and ] a lithium ion was used by the positive electrode containing the lithium manganese multiple oxide and electric conduction material which have a spinel mold crystal structure, and a binder, and charge and discharge according to this invention as explained above While being able to consider as high capacity and high power, the amount of application of a lithium manganese multiple oxide is made into 80 g/m<sup>2</sup> thru/or 160 g/m<sup>2</sup>. And since mass of electric conduction material was made into 10 mass % thru/or 12 mass % and mass of a binder was made into 3 mass % thru/or 5 mass % Since the gas evolution from an internal pressure disconnection device is performed very quietly, though it is high capacity and high power, the effectiveness that a nonaqueous electrolyte rechargeable battery with very high safety is realizable can be acquired.

---

[Translation done.]